Prouts Neck Quadrangle, Maine

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On the geologic map, different bedrock units are indicated by colors and identified by letter symbols that represent their assigned age and unit name. The following description summarizes the major rock types of each unit and gives a simplified geologic history by which they formed.

GEOGRAPHY

The northern two thirds of the quadrangle consists of low-lying land with extensive estuaries and salt water marshes (Scarborough, Nonesuch, and Spurwink Rivers). Extensive sand beaches (Photo 1) dominate the southwestern shoreline (Old Orchard, Western, and Scarborough Beaches and Back Shore), whereas ledges dominate the northeastern shoreline. Prouts Neck, whose shoreline is ledge girded, is a former island tied to the mainland by an emergent tombolo made up of Western Beach and the southwestern end of Scarborough Beach. Scarborough Beach marks the northeastern end of the southern coastal beach zone. Northeast of this is the beginning of the bold and indented coast of Maine (Photo 2).

Topography in the land area of the Prouts Neck quadrangle is low, never exceeding 150 feet in elevation. Much of the western half of the quadrangle is extensively covered by glacial and postglacial sediments. Outcrops are relatively rare. Bedrock exposures are abundant in the eastern half of the quadrangle, and in particular, in the area of the northeast and east-central portions of the map sheet.

MAJOR ROCK TYPES

The stratified, or layered, rocks of the Prouts Neck quadrangle are all metamorphic rocks, including schist, phyllite, gneiss, granofels, and amphibolite. Schist consists mostly of thin, flat flakes of mica which are arranged parallel to each other such that the rock splits into thin sheets. Phyllite has a similar mineral texture except the individual grains are very small and not readily seen without a microscope. Granofels, made up primarily of the minerals quartz and feldspar, has a grainy texure somewhat like sugar. In contrast with schist and phyllite, gneiss and granofels tend to break into angular blocks or chunks. Amphibolite is a rock named for dark grains of the mineral amphibole, the principal constituent of the rock. Varieties of gneiss, schist, and granofels may be further distinguished by their particular mineral content, grain size, color, or other characteristics.

ORIGIN OF THE STRATIFIED ROCKS

The oldest rocks of the Prouts Neck quadrangle belong to the Casco Bay Group, a diverse assortment of metamorphosed volcanic rocks, shales, and limestone, deposited during Ordovician time (see Geologic Time Scale, below). The oldest unit of the Casco Bay Group is the Cushing Formation, a thick pile of light gray volcanic material composed of fine metamorphosed crudely to well-layered volcanic ash (Photo 3). These rocks formed as hot lava erupted on an ancient ocean floor and became fragmented on contact with the cold ocean water. As volcanic activity ended, shale and siltstone of the Cape Elizabeth Formation (Photo 4) accumulated in thin beds conformably on top of the volcanic pile. A period of renewed volcanism ensued, depositing basaltic ash (Photo 5) of the Spring Point Formation. In places, dark shale of the Diamond Island Formation (Photo 6), rich in organic matter and iron sulfide, accumulated after cessation of the basaltic volcanism. This was followed by accumulation of more shale and siltstone of the Scarboro (Photo 7) and Jewell Formations and shaly limestone of the Spurwink Metalimestone (Photo 8).

The Merrimack Group, much more extensively exposed in the southwestern part of Maine, is represented in the Prouts Neck quadrangle by the Eliot Formation, a sequence of slightly metamorphosed calcareous siltstone and shale; and the Kittery Formation, consisting of thin to medium-bedded metamorphosed feldspathic sandstone and shale. These rocks are interpreted to be deep ocean sediments deposited during Late Ordovician to Early Silurian time.

DEFORMATION, METAMORPHISM, FAULTING, AND IGNEOUS INTRUSION

Rocks of all the stratified sequences were complexly folded during a period of major regional deformation and mountain-building known as the Acadian orogeny, in Early to Middle Devonian time. Large-scale deformation of the Earth's crust is indicated by large folds in the map pattern and cross sections; minor folds and other internal structural complexities can be seen in outcrop at many localities. Early folds are recumbent (Photo 9) and are accompanied by minor thrust faulting (Photo 10). Late folds are upright (Photo 11). During late stages of this deformation period, the rocks were forced to deep levels in the Earth's crust where heat and pressure gradually transformed the sedimentary and volcanic rocks into the metamorphic rocks that we see now. Shale was transformed into phyllite and schist; sandstone became granofels; volcanic ash of basaltic composition became amphibolite; and limestone was transformed into fine-grained marble.

After the Acadian orogeny the rocks of the quadrangle were subjected to major faulting and shearing while still deep in the Earth's crust, forming the Norumbega fault zone which, in this area, includes the Broad Cove fault. Shear bands associated with this faulting can be seen in Photo 7. This ancient fault zone resembles the present-day San Andreas fault in California. Later faulting, with vertical rather than sideways motion, formed the major normal faults of the quadrangle, the Johns Point and South Portland faults.

The youngest rocks in the area are the numerous dark-colored basalt and diabase dikes that were injected into extensional fractures produced during continental rifting of the incipient Atlantic Ocean in Mesozoic time (Photo 4). These dikes range in thickness from a few inches to 15 feet in the Prouts Neck quadrangle. The present landscape and ocean bathymetry are fundamentally controlled by uneven erosion of the complex underlying bedrock geology over great spans of time, modified by recent and ongoing surface processes.

Photo 1. Beach, dune, and lagoonal sediments of Western Beach at the mouth of the Scarborough River, Scarborough, Maine.

Photo 2. Beginning of the bold and indented rocky shore characteristic of much of the coast of Maine to the north. Ram Island Farm, Cape Elizabeth.

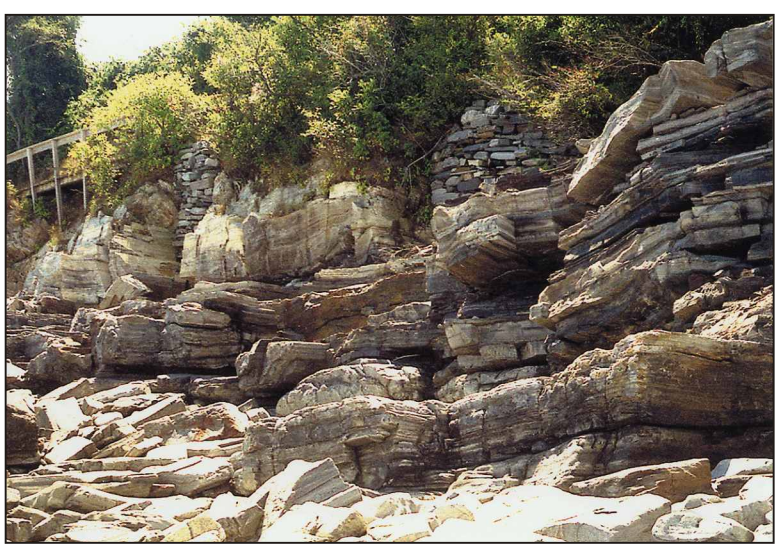

Photo 3. Light gray metamorphosed volcanic ash, in places weakly bedded, of the Cushing Formation, Prouts Neck, Scarborough, Maine.

Photo 4. Thin-bedded metamorphosed sandstone and shale of the Cape Elizabeth Formation intruded by a 1 meter Mesozoic-age basalt dike with prominent columnar cooling joints. Ram Island Farm shoreline, Cape Elizabeth.

Photo 5. Massive amphibolite of the Spring Point Formation. Rogers Brothers Quarry, Sawyer Road, Cape Elizabeth.

Photo 6. Black, pyrite-rich phyllite of the Diamond Island Formation. Small side lane off Highland Avenue, South Portland.

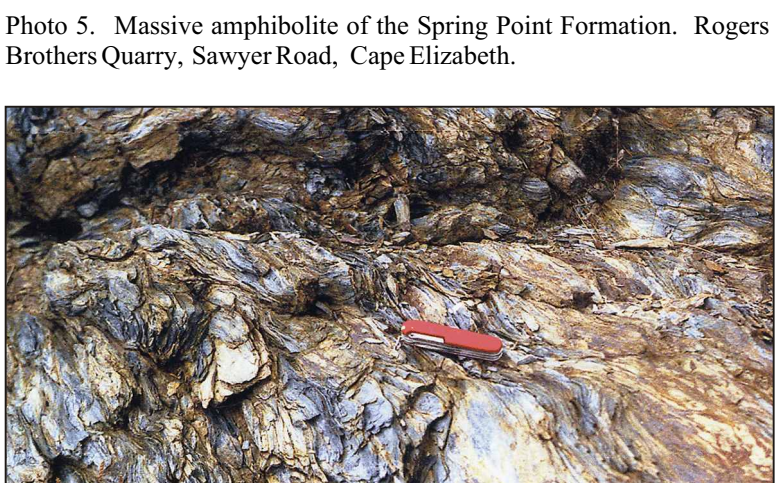

Photo 7. Rusty-weathering phyllite of the Scarboro Formation. Higgins Beach, Scarborough. Shear bands in the phyllite are interpreted to be the result of strike-slip movement during the development of the Norumbega fault zone.

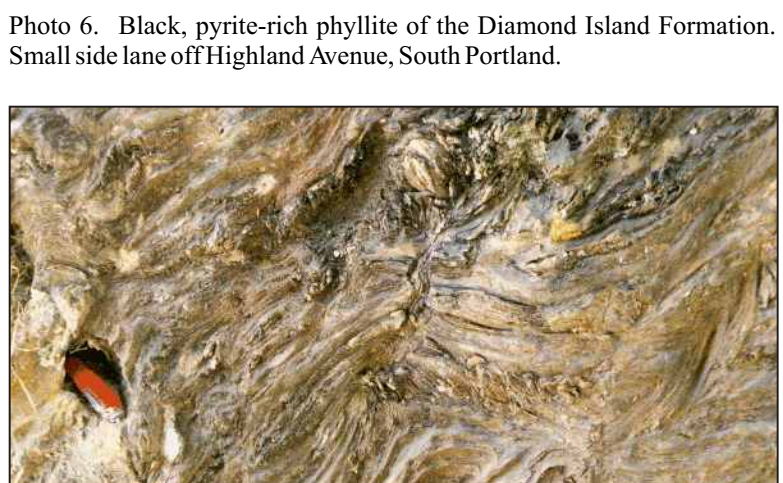

Photo 8. Thin-, ribbony-bedded Spurwink Metalimestone. Higgins Beach area, Scarborough.

Photo 9. Early recumbent folds of beds of metamorphosed volcanic ash within the Cushing Formation. Prouts Neck, Scarborough.

Photo 10. Thrust fault in the Cape Elizabeth Formation. The fault surface is inclined to the right (northwest), and the beds above the surface show drag folds indicating movement to the southeast over the beds below the surface.

Photo 11. Late upright folds of bedding and quartz veins in metamorphosed volcanic rocks of the Spring Point Formation, off Highland Avenue, South Portland.

GEOLOGIC TIME SCALE

Geologic Age		Absolute Age*
Cenozoic Era		0-65
Mesozoic Era	Cretaceous Period	65-145
	Jurassic Period	145-200
	Triassic Period	200-253
Paleozoic Era	Permian Period	253-300
	Carboniferous Period	300-360
	Devonian Period	360-418
	Silurian Period	418-443
	Ordovician Period	443-489
	Cambrian Period	489-544
Precambrian time		Older than 544

* In millions of years before present. (Okulitch, A. V., 2002, Échelle des temps géologiques, 2002: Commission géologique du Canada, Dossier Public 3040 (Série nationale des sciences de la Terre, Atlas geologique) - RÉVISION.)